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GB 0877447

(58) Field of search
E1D

(54) **Ventilated roofing**

(57) Corrugated or plain roofing panels (14,15,16) are held onto underlying purlins (11,12,13) by fixing means with spacers (10,17) between adjacent edges of adjacent sheets such that one of each pair of adjacent sheets is offset from the plane of the other leaving a space at least along its longitudinal edges for ventilation purposes. The spacer elements include means for interengaging with the edges of the sheets or corrugations thereof in order accurately to align the adjacent sheets with one another so that no misalignment of the sheets takes place over the area of the roof. The spacers may also support overlapping sheet edges of the sheets. Various forms of spacers are described (21—Fig. 2, 31—Fig. 3, 43/46—Fig. 4, 57/58—Fig. 5, 61—Fig. 6). Those of Fig. 4 are formed integrally with the panels.

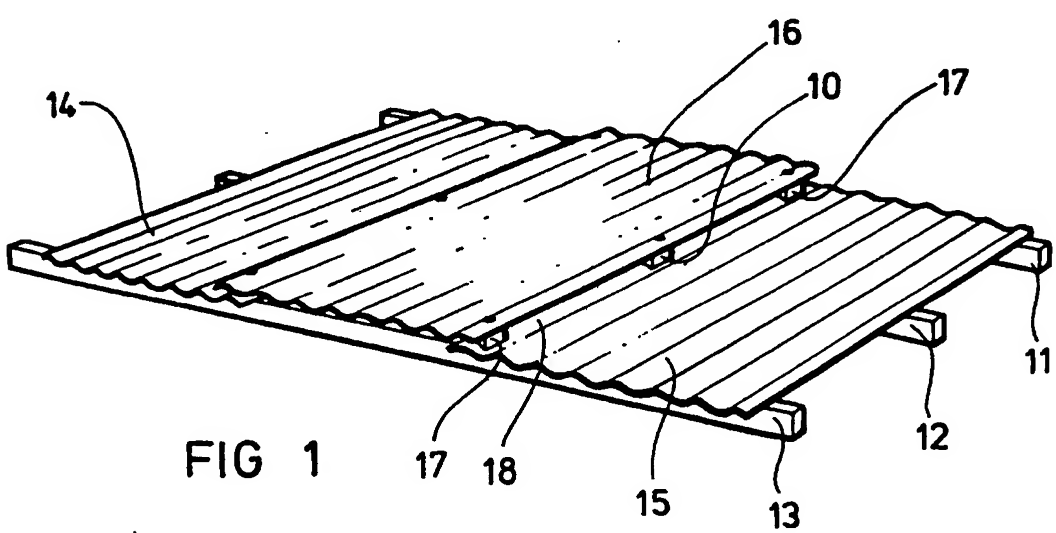

FIG 1

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The drawing(s) originally filed was/were informal and the print here reproduced is taken from a later filed formal copy.

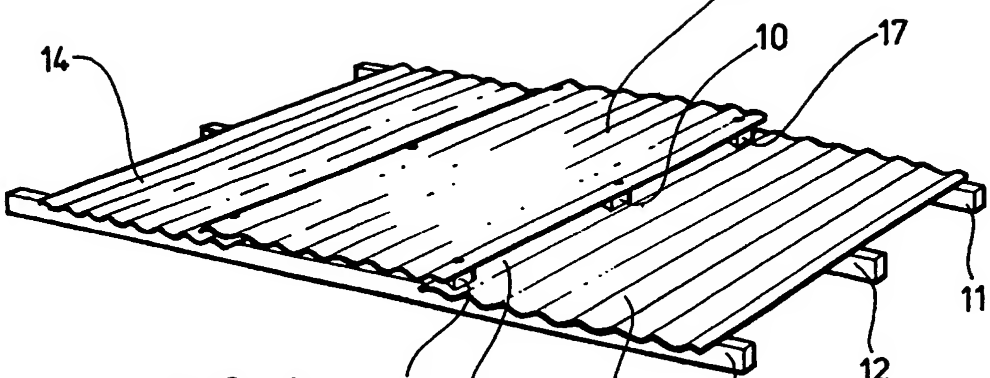

FIG 1

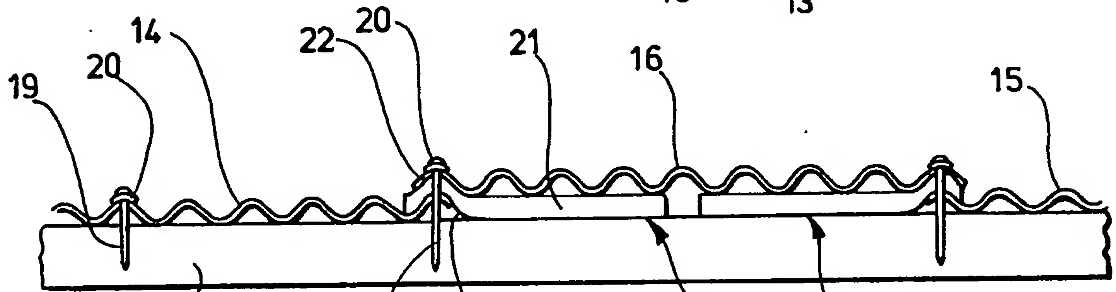

FIG 2

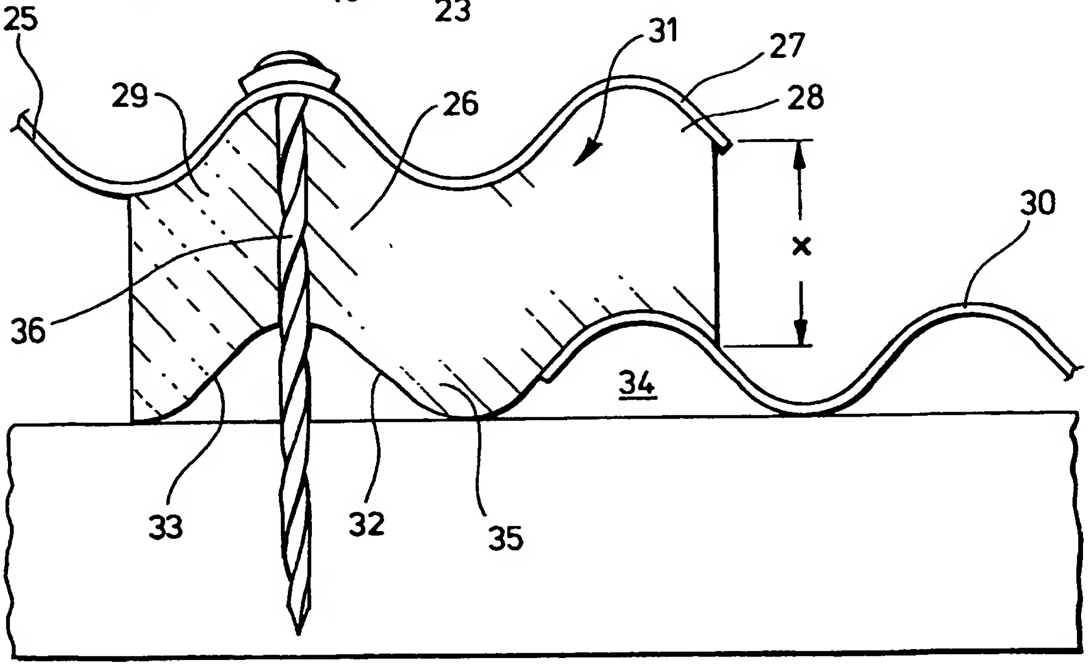

FIG 3

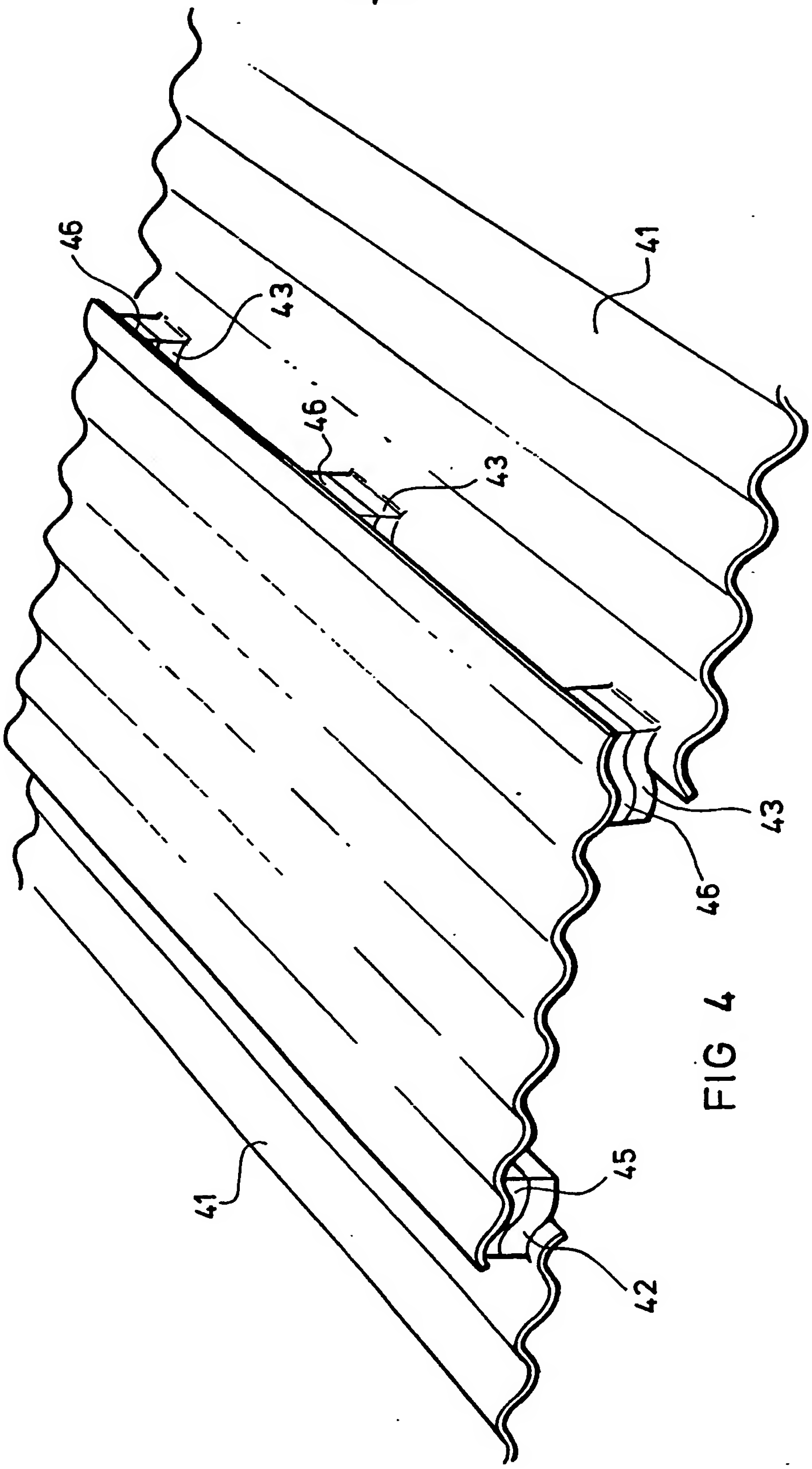

FIG 4

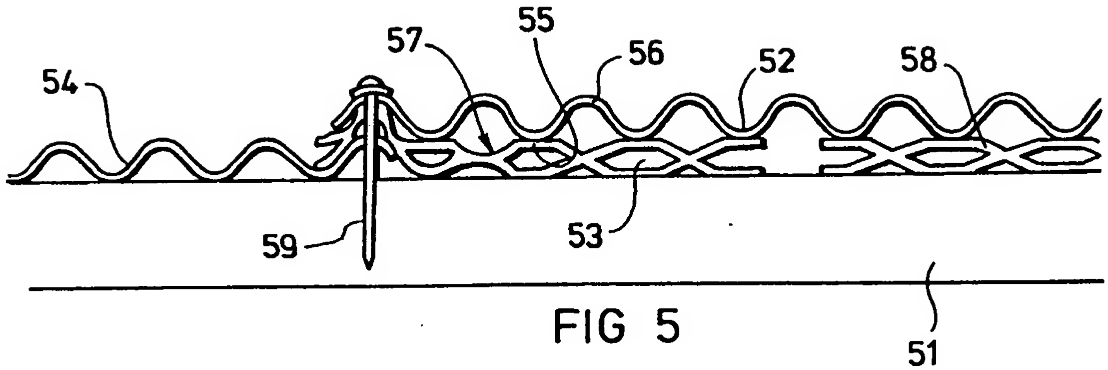

FIG 5

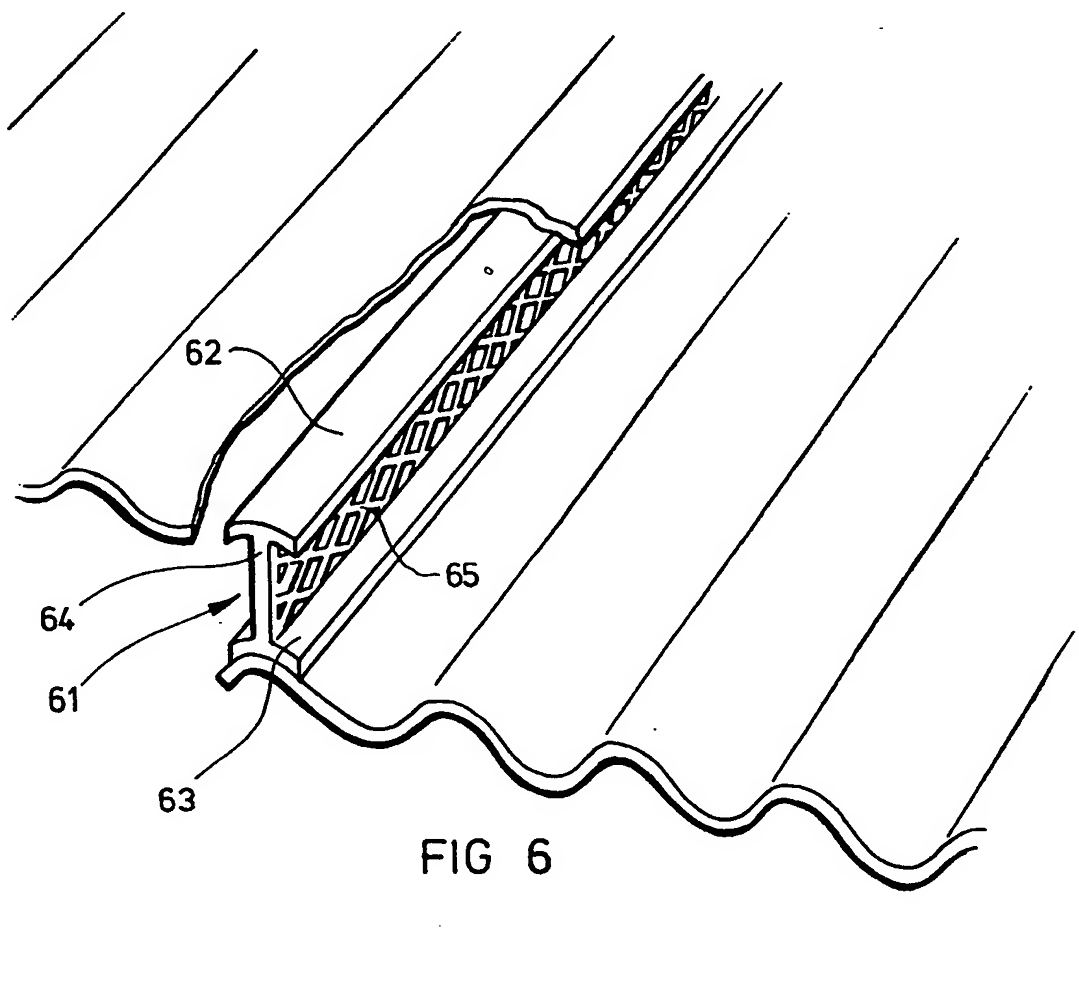

FIG 6

SPECIFICATION

Improvements in or relating to ventilated roofing

The present invention relates generally to roofing, and particularly to ventilated roofing formed by a plurality of roof cladding elements secured to the supporting framework.

It has long been known that large buildings intended for housing livestock should be adequately ventilated in order to provide the appropriate conditions for the livestock, and this has been achieved in the past by the provision of ventilation openings, particularly openings along the ridge of a building. In recent years livestock housing has increased in size dramatically, and it has been found that the overall volume within a building cannot adequately be ventilated simply by apertures at the ridge, even if supplemented with openings in the side walls and/or along the eaves of the building since the interior volume of a building increases with the cube of the dimensions whereas the area available along the ridge at the eaves, for example, increases only in proportion to its linear dimensions. The amount of air which must be moved through the building in order to effect satisfactory ventilation thus increases, with the increase in dimensions of the building, at a faster rate than the existing ventilation systems can cope with and alternative, more effective ventilation systems have to be devised in order to allow sufficient air flow for the livestock.

One proposal for effecting such ventilation, which is usable when the buildings are roofed with cladding sheets is to offset the sheets from one another in a direction transversely of the general plane of the sheets. This leaves longitudinal apetures which, if desired, can be spaced over the whole area of the roof thereby substantially increasing the ventilation area without leaving any aperture of a substantial size to permit the ingress of precipitation. A major problem with this proposal lies in the fact that the corrugations of the sheets are, in themselves, used to align the sheets with one another since the left and right hand edges are shaped to fit snugly by making the outer radius of one edge correspond with the inner radius of the other. When the sheets are offset from one another there is no direct interengagement between adjacent corrugations and the problem of accurately aligning the sheets becomes more difficult, particularly when a large roof area is being constructed, and accurate alignment of adjacent sheets is of considerable importance in ensuring that the roof cladding follows exactly the same shape as the frame.

According to one aspect of the present invention, therefore, there is provided a spacer element for sheet cladding, particularly but not exclusively sheet cladding having corrugations, the element being shaped to fit between two adjacent sheets and locate them in a predetermined relative lateral position and at a predetermined separation transversely of the general plane of the sheets.

The term "general plane" when applied to corrugated sheets will be understood to refer to the plane in which corresponding parts of the sheet lie. For example, the crests of adjacent corrugations all define a single plane.

The present invention also comprehends a spacer element as defined hereinabove in which upper and lower faces of the spacer element each have at least one ridge and/or one valley in the form of corrugations matching those of the cladding sheets with which they are intended to cooperate. In use the spacer elements are fitted over one or more of the ridges at or adjacent the edge of a sheet, and the next adjacent sheet is fitted over the spacer elements, with its ridges and valleys fitting into the ridges and valleys of the spacer element thereby locating the ridges and valleys of the adjacent sheets with relation to one another in exactly the same way as they would be located if the sheets were directly superimposed over one another.

The spacer element of the present invention may have at least one ridge and one valley and the remainder of each face of the element may be substantially flat. In this case the length of each element may be at least one half of the width of the sheets with which they are intended to be used. The spacer of the present invention may further be provided with means for locating and retaining the spacer on a purlin before it has been overlain by a cladding sheet. Since the uppermost face of a purlin is inclined to the horizontal such retainer is useful to make fitting easier: such retainer may comprise, for example, one or a pair of legs or lugs on the spacer element to extend down on either side of the purlin for location and retention of the spacer element.

In a preferred embodiment of the invention the said element has two ridges and a valley on one face and two valleys and a ridge on the other. This allows a degree of selection in positioning the element over one or two ridges and/or valleys adjacent the edge of a sheet.

The longitudinal extent of the element, that is its dimension parallel to the length of the ridges or valleys of the corrugations, is preferably less than or not substantially greater than its dimension transversely of the length of the said ridges and valleys of the corrugations. Indeed, if, as referred to above, each element extends for approximately one half of the width of each sheet, the "longitudinal" dimension need be no more than the width of the purlins on which the sheets are supported. The spacer of the present invention may alternatively be adapted to fit between two adjacent sheets along the longitudinal edge

thereof, particularly if very lightweight sheets of low rigidity are employed. In this case the spacer also lends a degree of rigidity to the cladding sheets. Of course, in this case, the spacer must itself be perforated or alveolar in order to permit the passage of air for ventilation. Any openings formed in such longitudinally extending spacers should preferably include means for excluding birds, however, particularly if the separation between the sheets is more than just a few cm. This may be the case, for example, if it is not practicable to ventilate a whole roof since then the desired airflow could only be achieved by raising the spaced sheets higher than would be the case if sheets could be raised over the whole of the roof area. Bird excluders could include mesh screens, wire bars or other means for reducing the individual aperture size.

The present invention also comprehends cladding sheet having reinforcing corrugations in which there are provided (either by integral formation or separate attachment) a plurality of spacer elements shaped to cooperate with one another and/or with the corrugations of the sheets whereby to serve in accurately aligning the sheets with one another with the corrugations, parallel and adjacent sheets offset or displaced from the general plane of each other.

There may be provided at least one such spacer element adjacent each corner of the sheet or, alternatively, each sheet may have a plurality of such elements located at suitable positions along their longitudinal and transverse edges. Because the sheets may be over-lapped longitudinally as well as laterally such integral spacers must be located a short distance from the end of the sheet and preferably not right at the end of the sheet.

As is usual with corrugated cladding sheets, it is envisaged that the corrugation along one edge will be shaped with a smaller radius than the corrugation along the opposite edge so that adjacent sheets can be interfitted closely.

According to another aspect of the present invention there is provided a roof comprising a plurality of cladding sheets of corrugated material, in which at least one of the sheets is displaced transversely of the general plane of the other sheets and located by spacer elements having locating means for interengaging the corrugations to align the adjacent edges of mutually offset sheets.

A roof formed in accordance with this aspect of the present invention may have every alternate sheet, in a direction transversely of the corrugations, offset from the plane of its neighbour and located by such spacer elements.

It will be appreciated that in large roofs, the corrugated sheets are also overlapped longitudinally, that is in a direction perpendicular to the purlins, extending from eaves to ridge. Thus, at each corner of a sheet, apart from the eaves and ridge edges, there are four thicknesses of material and the spacer of the present invention is adapted to accommodate such thicknesses.

Various embodiments of the present invention will now be more particularly described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a perspective view of a part of a roof structure incorporating offset corrugated sheets in accordance with the principles of the present invention;

Figure 2 is an edge view of the structure illustrated in Figure 1;

Figure 3 is an edge view of an alternative embodiment;

Figure 4 is a perspective view of a further alternative embodiment;

Figure 5 is an edge view similar to Figure 2, showing another alternative embodiment of the invention; and;

Figure 6 is another perspective view, partly cut-away, showing a further embodiment of the invention.

Referring first to Figure 1, there is shown a part of a roof structure incorporating three parallel purlins 11, 12, 13 which are of entirely conventional form. Attached to the purlins 11, 12, 13 by normal attachment fixings (not shown) are two corrugated cladding sheets, which may be made of corrugated iron, corrugated asbestos cement, or any of the plastics materials now being introduced for this purpose. The two cladding sheets 14, 15 are spaced from one another by a distance such as would be occupied by a cladding sheet itself, but in this case the intermediate cladding sheet 16 is offset (raised) from the general plane defined by the two sheets 14,15 and located in place by spacer elements 10, 17 such that there is a vertical separation leaving an air gap 18 longitudinally of the corrugations between adjacent sheets such as the sheets 15 and 16, and the sheets 14 and 15. The spacers 10 are only different from the spacers 17 in larger roofs where the sheets are longitudinally overlapped except at the ridge and the eaves, and here the spacer 10 is only different in that it is thicker than the spacer 17 since the latter has to accommodate four thicknesses of sheet material whereas the former has to accommodate only two. Even so this difference is not large since the sheet thickness may not be greater than a few millimetres.

The shape of the spacer elements 17 is shown in more detail in Figure 2 in which the individual fixings can also be seen. These fixings comprise, as is known, twisted nails 19,20 having a long pitch screw thread which encourages them to twist as they are driven home, and a cooperating spacing washer 20 made of resilient material for maintaining tension on the nail 19, 20 itself when driven

home, thereby securing the sheeting firmly on the purlin. For steel or concrete purlins, of course, hook bolts would be used instead.

The two spacer elements 17 illustrated in Figure 2 each comprise a straight portion 21 underlying four valleys of the sheet, and at each edge the element 17 has a single ridge 22 with a matching valley 23 in the opposite face. These spacer elements allow the "upper" sheet 16 to be accurately positioned with respect to a sheet, such as the sheet 14, preliminarily fixed to the purlins 13, etc., and the steps in fixing a set of cladding comprises first securing the sheet 14 along one edge with the fixing pins 20, then overlying the spacers 17 along the edge remote from that fixed with the pins 20, and overlying these spacers with the sheet 16, the ridge and valley 22, 23 of the spacer 17 serving accurately to locate the edge corrugation of the sheet 16 over the adjacent edge corrugation of the sheet 14, and then fixing the pin 20 through both corrugations and the spacer 17. Subsequently, or at the same time as fitting the sheet 16, the other spacer elements 17*b* are fitted and the sheet 15 slipped underneath prior to fixing with the pin 20. Although Figure 2 shows the sheets fixed at the edge corrugation it may be found in practice more convenient to fix the sheets at the penultimate or next adjacent corrugation.

In this way the two spacers 17*a*, 17*b* support each of the elevated sheets 16 above the level of the "lower" sheets 14,15 by a distance sufficient to allow the passage of air through the ventilation openings 18 whilst nevertheless offering the elevated sheets 16 exactly the same degree of support as it would have if it were resting on the purlin 13 since all of the valleys in the sheet 16 are in fact supported, and the space between adjacent support elements 17*a*, 17*b* is occupied by a ridge which would not come into contact with the purlin even if the sheet 16 were fitted on conventionally. Although it would be possible to provide a single spacer extending the full width covered by spacers 17*a* and 17*b*, this is not the preferred arrangement because of the need to accommodate width variations in the sheets.

The two spacer elements 17*a*, 17*b* are not identical, however, since the left and right edges of the corrugated sheets are not exactly identical. In fact, as will be appreciated, the left hand edge of the sheets are intended to underlie the right hand sheet of the adjacent sheet so that the terminal corrugations on the left hand edge of the sheet 15 is in fact of a slightly smaller radius than that on the right hand edge allowing the two corrugations to overlap exactly despite the thickness in the material. For this reason the upper and lower curves of the corrugation of the element 17*b* have respectively a greater and a smaller radius whereas in the element 17*a* the upper curve has the smaller radius and the lower curve has the greater radius.

Referring now to Figure 3 there is shown an alternative embodiment usable with corrugated sheets having a greater degree of stiffness and therefore not requiring support along the whole of their width. The spacer element shown in Figure 3 is illustrated separating two corrugated sheets 25,30 by a distance X representing the thickness of the spacer itself.

The spacer 26 in this embodiment has an upper face 27 with two ridges 28,29 and a single valley 31 whilst the lower face 32 has two valleys 33, 34 and a single ridge 35. The provision of two ridges in the upper face allows a fixing pin such as the pin 36 to be fitted through the penultimate corrugation of the upper sheet 25 without passing through the lower sheet 30 so that the lower sheet 30 is fixed in position simply by the interengagement of the adjacent corrugation of the element 26. Additional spacer elements such as the element 26 may be positioned at the other edge of the sheet 25 and, if desired, an intermediate element may be positioned midway between the two edges.

It is conventional for the spacing of the purlins 11, 12, 13 to be such that each corrugated sheet is supported at each end and in the middle by a purlin so that, if each purlin supports three support elements 26 there would be nine points of support distributed over the area of the "elevated" sheet 16 or 25.

Figure 4 illustrates a further alternative embodiment in which the sheets themselves are integrally moulded with appropriate spacer elements along the two parallel longitudinal edges. These sheets comprise two types, a first type 41 intended to be fitted to the supporting purlins directly, and each of the sheets 41 is provided with a number of upstanding spacer elements 42 along the right hand edge and 43 along the left hand edge. The other type of sheet is intended to be fitted over the upstanding spacer elements 42, 43 and comprises a corrugated sheet 44 having corresponding downwardly projecting spacer elements 45 along the left hand edge and 46 along the right hand edge. The six points of interengagement between the sheets 41 and the sheets 44 are thus made by contacting the downwardly projecting spacers 45 and 46 over the upwardly projecting spacers 42 and 43. The spacers 42 and 43 have upwardly convex cylindrical curvature matching that of the adjacent corrugations of the sheets 41. The downwardly projecting spacers 45, 46 of the sheet 44, on the other hand, extend across both a ridge and a valley and therefore have a corresponding cylindrical concave and cylindrical convey curvature corresponding to the ridge and valley adjacent the edge of the sheet. The elements 46 and 43 at the ends of the sheet are spaced by a short distance from

the end to permit overlapping as described.

As in the embodiments of Figures 1 to 3, the attachment of the sheets 41 and 44 to the underlying supporting purlins is effected by passing pins through the sheets and the spacers.

In an alternative embodiment (not illustrated) a single spacer is shaped to span the whole width of a sheet, the spacer being provided with means intermediate its length for making small adjustments thereto for the purpose of accommodating variations in the width of the cladding sheets due to manufacture intolerances. Such length variations may be made by a concertina-type portion of narrow section or by a telescopic arrangement or laterally adjacent arms.

Turning now to Figure 5, there is shown a further embodiment in which a corrugated sheet 56 is held on a purlin 51, for example, by conventional fixing pins 59, but spaced from the purlin 51 by a spacer 57 underlying the corrugated sheet 56 and having a part overlying the adjacent corrugated sheet 54 which is positioned in contact with the purlin 51. The spacer 55 itself has a lattice-like structure with apertures 53 in part to increase the flow cross section at the lower edge of a corrugated sheet to enable the maximum amount of air flow to take place at this point, and in part to reduce the amount of material used in its production. As in the embodiment of Figure 2 a similar, mirror-image spacer 58 is positioned to span from the centre of the corrugated sheet 56 to the other edge. The dimensions of the lattice structure of the spacers 57,58 would, in this case, have to be matched with the dimensions of the corrugated sheets 56, 54 in order to ensure that the troughs 52 of the sheets are securely in contact with respective arms 55 of the spacers.

There may be occasions when large, very lightweight sheets of cladding material are used, and if such sheets have relatively little rigidity this may be improved using a spacer such as that illustrated in Figure 6 which may extend the full length of the sheet parallel to the corrugations spanning the gap between the crest at the edge of the underlying sheet and the crest at the edge of the overlying sheet. For this purpose the spacer 61 is formed with a generally I-shaped cross section with an upwardly convex upper flange 62 and a downwardly concave lower flange 63 spanned by a web 64 having a plurality of perforations 65 which, however, do not detract from the strength of the web. In such a construction the transverse corrugated upper and lower edges of the sheets would, as in the earlier embodiments, also be supported by a spacer, preferably one having apertures as in the embodiment of Figure 5.

Embodiments are also envisaged in which a spacer such as that shown in Figure 6 is formed as an intergral part of a roofing sheet.

It is also envisaged that spacers such as that illustrated in Figure 6 may be combined with spacers such as that illustrated in Figure 2 or Figure 5 to form a spacer frame.

CLAIMS

1. A spacer element for sheet cladding, particularly corrugated sheet cladding, the element being shaped to fit between two adjacent sheets and locate them in a predetermined relative lateral position and at a predetermined separation transverse the general plane of the sheets.

2. A spacer element as claimed in Claim 1, in which upper and lower faces of the spacer element each have at least one ridge and/or at least one valley in the form of corrugations matching those of the cladding sheets with which they are intended to cooperate.

3. A spacer element as claimed in Claim 1 or Claim 2 in which each of the upper and lower faces has at least one ridge and one valley and the remainder of each face is substantially flat, the length of each element being in the region of one half of the width of the sheets with which they are intended to be used.

4. A spacer element as claimed in any of Claims 1 to 3 in which each of the said upper and lower faces of the said element have two ridges and a valley or two valleys and one ridge.

5. A spacer element as claimed in any preceding Claim, in which the longitudinal extent of the element, that is its dimension parallel to the length of the ridge or valleys of the corrugations, is less than or at least not substantially greater than its dimension transversely of the length of the ridges and valleys of the corrugations.

6. A spacer element as claimed in any preceding Claim in which the body of the spacer is provided with apertures or perforations to permit the passage of air.

7. A spacer element as claimed in Claim 6, in which the body of the spacer has a skeletal structure.

8. A spacer element as claimed in any of Claims 1 to 7, in which the body of the spacer is shaped to cooperate with the single corrugation of each overlapping sheet, and to extend along the length of such corrugations.

9. A cladding sheet having reinforcing corrugations in which there are provided, integrally or attachably, a plurality of spacer elements shaped to cooperate with one another and/or the corrugations of the sheets whereby to serve in accurately aligning the sheets with one another with the corrugations parallel and adjacent sheets offset or displaced from the general plane of one another.

10. A cladding sheet as claimed in Claim 9, in which there are provided at least one spacer element at each corner of the sheet.

11. A cladding sheet as claimed in Claim 10, in which there are additionally provided one such spacer element midway along each long edge of the sheet and/or one along each short edge of the sheet.

12. A cladding sheet as claimed in any of Claims 9, 10 or 11 in which the corrugation along one edge of the sheet is shaped to fit into the corresponding corrugation in the other edge thereof, and the spacer elements are of corresponding sizes at opposite faces thereof to cooperate with the opposite corrugations of adjacent sheets.

13. A roof comprising a plurality of cladding sheets of corrugated material, in which at least one of the sheets is displaced transversely of the general plane of the other sheets and located by spacer elements having locating means for interengaging the corrugations to align the adjacent edges of mutually offset sheets.

14. A roof as claimed in Claim 13, in which every alternate sheet, in a direction transversely of the corrugations, is offset from the plane of its neighbour and located by such spacer elements.

15. A spacer element substantially as hereinbefore described with reference to and as shown in any of Figures 1 to 6 of the accompanying drawings.

16. A roof cladding sheet substantially as hereinbefore described with reference to Figure 4 of the accompanying drawings.

17. A roof structure incorporating offset sheets and spacer elements substantially as hereinbefore described with reference to, and as shown in, the accompanying drawings.

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